6/PRTS

09/856982

531 Rec'd PCT 30 MAY 2001

DESCRIPTION

METHOD FOR INSPECTING SEMICONDUCTOR WAFER SURFACE

Technical Field

The present invention relates to a method for inspecting a semiconductor wafer surface and, more particularly, to a method for inspecting a semiconductor wafer surface for dividing to detect according to the types defects present on and near a semiconductor wafer surface, particles adherent thereto and the like (hereinafter referred to as defects etc., including those), which affect the electrical properties such as dielectric breakdown strength of LSIs and the like being manufactured using semiconductor wafers, so as to evaluate the semiconductor wafer quality.

09856982.053001

Background Art

Hitherto, extraneous substances such as particles adherent onto a semiconductor wafer, and crystal defects on and near the surface thereof or surface flaws, scratches, shallow pits and the like (hereinafter referred to as surface flaws etc., including those) have been known as light point defects (LPDs) to be detected using a semiconductor wafer surface inspection apparatus. The extraneous substances among them are observed in the shape of a convex on the semiconductor wafer surface. The crystal defects etc. are observed mainly as a quadrangular-pyramidal pit or projection [(100) wafer], or, a triangular or hexagonal pit or projection [(111) wafer] on a mirror-finished wafer surface, while they are observed mainly in the shape of a square or a square partly concave or convex [(100) wafer], or in the shape of a triangle or a triangle partly concave or convex [(111) wafer] on an epitaxial wafer surface.

From the viewpoint of the evaluation of semiconductor wafer quality, it is desirable that the extraneous substances, crystal defects and surface flaws etc. should be strictly divided according to their types to be detected. However, in a conventional method for inspecting a semiconductor wafer surface, a wafer is scanned with a laser beam, a scattered light having a prescribed angle, being reflected from the wafer surface, is detected, and the result is compared with the measurement results of standard particles having prescribed grain sizes previously obtained, whereby the number of LDPs of every size including all of the extraneous substances and crystal defects is obtained.

In order to determine the types of extraneous substances and crystal defects etc., or surface flaws etc. (hereinafter referred to as defects etc., including those) in the above

method, the possibility of separation by the unevenness recognition based on the premise that grown-in defects are pit-shaped while particles are convex, for example, in the separation of particles and grown-in defects (COPs) in a mirror-finished wafer was reported. However, since the unevenness recognition is actually imperfect, it has been evident that it is difficult to separate particles from grown-in defects (COPs). In addition, it has been evident that all of the grown-in defects are not concave.

There are many types of crystal defects in an epitaxial wafer such as stacking faults (SFs), mounds, and dislocations (hereinafter referred to as epi defects), and some of the epi defects have concave shapes, some have convex shapes, and others have both concave and convex shapes. Therefore, since the separation probability in the method wherein the separation is conducted depending on the concave and convex shapes is low, and all of the epi defects are not concave, it has been physically impossible to separate the epi defects from particles, moreover, to determine the types of the defects.

The determination of the types of the defects etc. is possible using an atomic force microscope (AFM) or a scanning electron microscope on a research level. However, in order to observe the defects etc. using these microscopes, the coordinate positions where the defects etc. exist must be detected first on a wafer surface having an enormously large area compared with the defects etc. The detecting activity is very hard, and then, the points where the defects etc. exist must be brought into focus of the AFM or the like. These activities cost vast labor and time, and furthermore, there is a possibility that the quality of the product might be lowered, though they are not destructive inspection. As a result, it has been actually impossible to conduct the inspection using a microscope of this type on every product. Therefore, a visual distinction method by an inspector (a method wherein a high-intensity spotlight is irradiated in a darkroom and scatterers are detected by a visual check) has been actually adopted.

The defect size measured using only one light optic of a laser surface inspection apparatus is a standard particle conversion size, which may be very different from an actual size depending on the shapes of the defects etc. Accordingly, there is a problem left from the viewpoint of reliability in the distinction of the types of the defects etc. based on the defect size. Not only does the method wherein particles and defects are separated by judging whether the shape is concave or convex, have a low reliability, but also it cannot be applied at all to the wafers wherein convex defects exist. In the visual distinction method by an inspector, the distinction capacity greatly depends on the inspector's competence for the task, which is not stable, and it is difficult to respond to higher-level requirements in a future wafer inspection. Furthermore, as wafers have

larger diameters, the possibility that defects etc. escape his attention becomes larger. In the visual distinction method by an inspector, the ability of the inspector must be estimated first, leading to increases in the step number and cost.

Disclosure of Invention

The present invention was developed in order to solve the above problems, and it is an object to provide a method for inspecting a semiconductor wafer surface, wherein particles adherent to a semiconductor wafer surface and, for example, surface flaws etc. in a mirror-finished wafer which exist near the semiconductor wafer surface, or grown-in defects etc. in the bulk near the surface can be separated to be detected, or adherent particles and defects etc. such as SFs, mounds, and dislocations in an epitaxial wafer can be accurately divided according to the types, without being influenced by the inspector's ability at a low cost.

In order to achieve the above object, a method for inspecting a semiconductor wafer surface (1) according to the present invention is characterized by a wafer being scanned with a laser beam, a scattered or reflected light from the wafer surface being detected by multiple light optics having different detecting angles to an incident light, and the defect being classified into some characteristics based on the ratio of the detected light intensities from the multiple light optics.

In the above method for inspecting a semiconductor wafer surface (1), since a wafer is scanned with a laser beam, a scattered or reflected light from the wafer surface is detected by multiple light optics having different detecting angles to an incident light, and the defect is classified into some characteristics based on the ratio of the detected light intensities from the multiple light optics, it can be utilized that there is a wide difference in the detected defect sizes between a low-angle light optic and a high-angle light optic depending on the types of the defects etc. Therefore, it becomes possible to quite accurately determine the types of the defects etc. Since the determination is not conducted by an inspector, the inspection can be automated. Without depending on the inspector's ability, it can be stable and it is possible to deal with higher-level requirements in a future wafer inspection and wafers having larger diameters. Moreover, it is unnecessary to estimate the inspector beforehand, leading to substantial reductions in the inspection step number and cost.

A method for inspecting a semiconductor wafer surface (2) according to the present invention is characterized by a wafer being scanned with a laser beam, a scattered or reflected light from the wafer surface being detected by multiple light optics having different detecting angles to an incident light, a difference between a horizontal

length and a vertical height or between a horizontal length and a horizontal length crossing at right angles of a LPD (Light Point Defect) present on the wafer surface, being calculated from a difference in the standard particle conversion sizes based on the ratio of the detected light intensities from the multiple light optics, and the forms and types of defects etc. present on the wafer surface being determined.

In the above method for inspecting a semiconductor wafer surface (2), since a wafer is scanned with a laser beam, a scattered or reflected light from the wafer surface is detected by multiple light optics having different detecting angles to an incident light, a difference between a horizontal length and a vertical height or between a horizontal length and a horizontal length crossing at right angles of a LPD (Light Point Defect) present on and near the wafer surface, is calculated from a difference in the standard particle conversion sizes based on the ratio of the detected light intensities from the multiple light optics, and the forms and types of defects etc. present on the wafer surface are determined, it is possible to distinctly separate the defects etc. from extraneous substances. Furthermore, it becomes possible to quite accurately determine the types of the defects etc. Since the determination is not conducted by an inspector, the inspection can be automated. Without depending on the inspector's ability, it can be stable and it is possible to deal with higher-level requirements in a future wafer inspection and wafers having larger diameters. Moreover, it is unnecessary to estimate the inspector beforehand, leading to substantial reductions in the inspection step number and cost.

A method for inspecting a semiconductor wafer surface (3) according to the present invention is characterized by using a laser surface inspection apparatus comprising at least two light optics to one incidence as a laser surface inspection apparatus in the method for inspecting a semiconductor wafer surface (1) or (2).

When at least two light optics, a low-angle light optic and a high-angle light optic, to an incident light are included as a light-detecting system of the laser surface inspection apparatus, the above method for inspecting a semiconductor wafer surface (1) or (2) can be performed. By using the laser surface inspection apparatus comprising two light optics to one incidence as a laser surface inspection apparatus, the inspection cost can be held down.

A method for inspecting a semiconductor wafer surface (4) according to the present invention is characterized by the semiconductor wafer being an epitaxial semiconductor wafer in any of the methods for inspecting a semiconductor wafer surface (1)-(3).

By the method for inspecting a semiconductor wafer surface according to the

present invention, it is possible to accurately determine the types of defects etc. present on the wafer surface. Therefore, they can be applied even to an epitaxial semiconductor wafer which has many types of defects etc. and has a small number of defects.

A method for inspecting a semiconductor wafer surface (5) according to the present invention is characterized by determining the forms and types of defects etc. according to a combination of A, B and a numerical value given by A/B, where the detected light intensity of a LPD (Light Point Defect) detected in a high-angle light optic or the standard particle conversion size thereof is A, while the detected light intensity of the LPD detected in a low-angle light optic or the standard particle conversion size thereof is B, in any of the methods for inspecting a semiconductor wafer surface (1)-(4).

Using the above method for inspecting a semiconductor wafer surface (5), particles adherent to a semiconductor wafer surface, or defects etc. such as SFs, mounds, and dislocations present near the semiconductor wafer surface can be accurately classified, so that the semiconductor wafer quality can be accurately evaluated.

A method for inspecting a semiconductor wafer surface (6) according to the present invention is characterized by determining the forms and types of defects etc. based on Table 1, where the standard particle conversion size of a LPD (Light Point Defect) detected in a high-angle light optic is A, while the standard particle conversion size of the LPD detected in a low-angle light optic is B, in any of the methods for inspecting a semiconductor wafer surface (1)-(4).

Table 1

Relations between A and B or ranges	Actual for ms
Ａ≧Ｂ×１．１３	Stacking Fault
Ａ＜Ｂ×１．１３	Non-epi-layer originated extraneous substance (adherent particle)
Ｂ＜９０ｎｍ and Ａ＞１０７ｎｍ	Micro-crystallographic-defect (hillock, shadow, dislocation)
Ｂ＞１６０ｎｍ and Ａ＜１０７ｎｍ	Abnormal growth (large-pit, projection)
Others	Abnormal product

Using the above method for inspecting a semiconductor wafer surface (6), particles adherent to a semiconductor wafer surface, or defects etc. such as SFs, mounds, and dislocations present near the semiconductor wafer surface can be accurately classified, so that the semiconductor wafer quality can be accurately evaluated.

A method for inspecting a semiconductor wafer surface (7) according to the

present invention is characterized by the semiconductor wafer being a mirror-finished semiconductor wafer in any of the methods for inspecting a semiconductor wafer surface (1)-(3).

By the method for inspecting a semiconductor wafer surface according to the present invention, defects etc. present on the wafer surface, and surface flaws etc. and grown-in defects in the bulk near the surface can be accurately separated. Therefore, they can be applied even to a mirror-polished semiconductor wafer.

A method for inspecting a semiconductor wafer surface (8) according to the present invention is characterized by determining the forms and types of defects etc. according to a combination of A, B and a numerical value given by A/B, where the detected light intensity of a LPD (Light Point Defect) detected in a high-angle light optic or the standard particle conversion size thereof is A, while the detected light intensity of the LPD detected in a low-angle light optic or the standard particle conversion size thereof is B, in the method for inspecting a semiconductor wafer surface (7).

Using the above method for inspecting a semiconductor wafer surface (8), particles adherent to a semiconductor wafer surface or COPs, and surface flaws etc. and grown-in defects etc. present in the bulk near the semiconductor wafer surface can be accurately classified, so that the semiconductor wafer quality can be accurately evaluated.

A method for inspecting a semiconductor wafer surface (9) according to the present invention is characterized by determining the forms and types of defects etc. based on Table 2, where the standard particle conversion size of a LPD (Light Point Defect) detected in a high-angle light optic is A, while the standard particle conversion size of the LPD detected in a low-angle light optic is B, in any of the methods for inspecting a semiconductor wafer surface (1)-(3) and (7).

Table 2

Relations between A and B or ranges	Actual for ms
$A \geqq B \times 1.13$ or $B < 90$ nm and $A > 107$ nm	Scratch, flaw, and shallow pit
$A < B \times 1.13$	Adherent particle or COP
$B \geqq 85$ nm and $A < 107$ nm	Grown-in defect in bulk near surface

Using the above method for inspecting a semiconductor wafer surface (9), particles adherent to a semiconductor wafer surface or COPs, and surface flaws etc. and grown-in defects etc. present in the bulk near the semiconductor wafer surface can be

accurately classified, so that the semiconductor wafer quality can be accurately evaluated.

Brief Description of Drawings

Fig. 1 is a diagram showing the results of classification of the actual forms of LPDs detected in an embodiment 1 according to the present invention after confirmed using an AFM;

Fig. 2 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 3 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 4 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 5 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 6 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 7 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 8 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 9 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 1, which were confirmed using the AFM;

Fig. 10 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 2, which were confirmed using the AFM; and

Fig. 11 is a microphotograph showing an example of the actual forms of the LPDs detected in the embodiment 2, which were confirmed using the AFM.

Best Mode for Carrying Out the Invention

The preferred embodiments of the method for inspecting a semiconductor wafer surface according to the present invention are described below by reference to the Figures of the drawings.

In a method for inspecting a semiconductor wafer surface according to an embodiment, using, for example, a laser surface inspection apparatus having two light optics to one incidence, LPDs are detected in the two light optics, low-angle and high-angle ones, respectively. A list of the coordinates of the LPDs obtained in each

light optic, detected light intensity or standard particle conversion size data thereof, and (high-angle detected light intensity or standard particle conversion size / low-angle detected light intensity or standard particle conversion size) is prepared.

The LPDs detected only in the high-angle light optic, the LPDs detected only in the low-angle light optic, and the LPDs having various values of (high-angle detected light intensity or standard particle conversion size / low-angle detected light intensity or standard particle conversion size) are selected and the actual forms thereof are actually observed using an AFM or the like.

On the basis of the actual forms of the LPDs observed using the AFM or the like, the characteristics of defects etc. are grasped according to their types from the comparison between the detected light intensities or standard particle conversion sizes detected in each of the low-angle and high-angle light optics. As a result, for example, the relationships between the standard particle conversion sizes detected in each of the low-angle and high-angle light optics and the types of defects in an epitaxial wafer and in a mirror-finished wafer could be classified and arranged as shown in Tables 1 and 2, respectively.

Table 1

Relations between A and B or ranges	Actual for ms
$A \geqq B \times 1.13$	Stacking Fault
$A < B \times 1.13$	Non-epi-layer originated extraneous substance (adherent particle)
$B < 90\,nm$ and $A > 107\,nm$	Micro-crystallographic-defect (hillock, shadow, dislocation)
$B > 160\,nm$ and $A < 107\,nm$	Abnormal growth (large-pit, projection)
Others	Abnormal product

Table 2

Relations between A and B or ranges	Actual for ms
$A \geqq B \times 1.13$ or $B < 90\,nm$ and $A > 107\,nm$	Scratch, flaw, and shallow pit
$A < B \times 1.13$	Adherent particle or COP
$B \geqq 85\,nm$ and $A < 107\,nm$	Grown-in defect in bulk near surface

Here, A represents the standard particle conversion size of a LPD detected in the high-angle light optic, while B represents the standard particle conversion size of a LPD detected in the low-angle light optic.

However, the angles of the light optics are different depending on the used laser surface inspection apparatus, and each laser surface inspection apparatus has its own minimum and maximum limits of measurement. Therefore, there is a possibility that the values of A, B, and A/B used for defect distinction might vary according to laser surface inspection apparatus. In addition, in the case of an epitaxial wafer, the defect size depends on the thickness of the epitaxial film (in the case of a (100) wafer, the SF length is about 1.4 times the epitaxial film thickness), so that there is a possibility that the values of A, B, and A/B might vary when the epitaxial film thickness varies.

By a conventional method, in the case of an epitaxial wafer, the number of LPDs of every size in one light optic including all of the extraneous substances and epi defects detected using a laser surface inspection apparatus can be obtained, while in the case of a mirror-polished wafer, the number of LPDs of every size in one light optic including all of the extraneous substances and grown-in defects detected using a laser surface inspection apparatus can be obtained. However, it is impossible to divide and detect defects etc. according to the types as shown in Table 1 or 2.

The defect size measured using only one light optic of a laser surface inspection apparatus is a standard particle conversion size, which may be very different from an actual size depending on the shapes of the defects etc. Accordingly, there is a problem left from the viewpoint of reliability in the distinction of the types of the defects etc. based on the defect size. In the visual distinction method by an inspector, the distinction capacity greatly depends on the inspector's competence for the task, which is not stable, and it is difficult to respond to higher-level requirements in a future wafer inspection. Furthermore, as wafers have larger diameters, the possibility that defects etc. escape his attention becomes larger. In the visual distinction method by an inspector, the ability of the inspector must be estimated first, leading to increases in the step number and cost.

In the method for inspecting a semiconductor wafer surface according to the embodiment, on the basis of the coordinate data of the LPDs detected using the laser surface inspection apparatus, the LPDs detected only in the high-angle light optic, the LPDs detected only in the low-angle light optic, and the LPDs having various values of (high-angle detected light intensity or standard particle conversion size / low-angle detected light intensity or standard particle conversion size) are selected. On the basis of the results of the actual forms thereof actually observed using an AFM, the LPDs are classified and arranged to prepare Tables 1 and 2. Once the Table 1 or 2 is prepared, only the organization of the standard particle conversion sizes detected in each of the low-angle and high-angle light optics using the laser surface inspection apparatus according to the classification shown in Table 1 or 2 is needed to divide easily and

accurately the extraneous substances and defects etc. or surface flaws etc. according to their types.

Since the distinction is not conducted by an inspector, the inspection can be automated, so that it can be stably conducted without depending on the inspector's ability. It is also possible to deal with higher-level requirements in a future wafer inspection and wafers having larger diameters. Moreover, it is unnecessary to estimate the inspector beforehand, leading to substantial reductions in the inspection step number and cost.

In the method for inspecting a semiconductor wafer surface according to the embodiment, the case where the laser surface inspection apparatus having two light optics to one incidence is used as a laser surface inspection apparatus is described, but the laser surface inspection apparatus is not limited to the laser surface inspection apparatus having two light optics to one incidence. In another embodiment, a laser surface inspection apparatus having two light optics to two incidences or a laser surface inspection apparatus having three light optics to one incidence can be used.

When the laser surface inspection apparatus has at least two light optics having different detecting angles to an incident light as a light-detecting system thereof, it is possible to conduct the method for inspecting a semiconductor wafer surface according to the present invention. And using the laser surface inspection apparatus having two light optics to one incidence as a laser surface inspection apparatus, the inspection cost can be held down.

By the method for inspecting a semiconductor wafer surface according to the embodiment, the types of defects etc. present on a wafer surface can be accurately determined, so that the method can be applied not only to the detection of surface flaws of a mirror-polished semiconductor wafer sliced off from a single crystal, but also to an epitaxial semiconductor wafer having many types of defects etc. and a small number of defects. The quality evaluation of both the epitaxial semiconductor wafer having many types of defects etc. and the mirror-polished wafer can be accurately conducted.

Examples and Comparative Examples

Examples of the method for inspecting a semiconductor wafer surface according to the present invention are described below.

<u>Example 1</u>

Used laser surface inspection apparatus: SP-1 (produced by TENCOR)
Two light optics to one incidence

Used sample: 200 mm epitaxial silicon wafer

Wafer crystal plane (100)

Epitaxial film thickness 6 μm

The LPDs of the sample epitaxial silicon wafer were detected using the above laser surface inspection apparatus.

The data of the coordinates and standard particle conversion sizes of the LPDs obtained in each of the two light optics were organized, and the actual forms of the LPDs were presumed based on the classification shown in Table 1 and Fig. 1. Part of the results of the data processing are shown in Table 3.

Table 3

Detection results by laser surface inspection apparatus			AFM	Results
Low-angle light-receiving channel (nm)	High-angle light-receiving channel (nm)	Presumption		
Below detection limit	115	Micro-crystallographic-defect (dislocation, shadow)	Length 10 μm · height 3 nm (Fig. 2)	○
Below detection limit	160	Micro-crystallographic-defect (hillock)	Diameter 1 μm × height 20 nm (Fig. 3)	○
95	127	SF	SF (Fig.4)	○
108	136	SF	SF (Fig.5)	○
106	136	SF	SF	○
107	135	SF	SF	○
107	134	SF	SF	○
149	150	Adherent particle	Adherent particle (Fig. 6)	○
104	111	Adherent particle	Adherent particle	○
90	118	SF	SF	○
Above detection limit	Above detection limit	Mound	Mound · abnormal growth(Fig. 7)	○

Then, on the basis of the coordinate data of the obtained LPDs, the actual forms of the LPDs detected using the laser surface inspection apparatus were actually confirmed using an AFM, and whether the classification based on Table 1 and Fig. 1 was correct or wrong was judged. The results are also shown together in Table 3.

In Figs. 2-9, typical examples of microphotographs of the actual forms of the LPDs confirmed using the AFM are shown. In Table 3, in order to clarify to which the LPDs shown in Figs. 2-7 correspond, the Figure numbers are included in the AFM

column. The LPD shown in Fig. 8 is an example of LPDs which should be classified as the division (B > 160 nm and A < 107 nm) in Table 1, while the LPD shown in Fig. 9 is an example of LPDs which should be classified as the division (Others) in Table 1.

In the method according to the Example, the LPDs could be accurately classified according to their forms with a probability of at least 90 % or more by a simple method using a laser surface inspection apparatus.

<u>Comparative Example 1</u>

Used laser surface inspection apparatus: SFS6220 (produced by TENCOR)
One light optic to one incidence

Used sample: 200 mm epitaxial silicon wafer
Wafer crystal plane (100)
Epitaxial film thickness 2.1 μm

The LPDs of the sample epitaxial silicon wafer were detected using the above laser surface inspection apparatus.

As Comparative Example, the classification based on the standard particle conversion size data of the LPDs using the laser surface inspection apparatus and the classification by the method wherein a high-intensity spotlight is irradiated in a darkroom and scatterers are detected by a visual check were conducted. The actual forms of the detected LPDs were confirmed using an AFM and whether the classification was correct or wrong was judged. The results are shown in Table 4.

Table 4

Laser surface inspection apparatus	Visual check	AFM
0.1μm> 10 LPDs	None	10 SFs (3 μm-side square, L-shaped, U-shaped and linear)
0.1−0.3μm 5 LPDs	3 SFs	2 SFs (3 μm-side square), 1 pit of diameters 3.0 μm × 0.2 μm, 1 abnormal crystal growth, and 1 adherent particle
0.3μm< 3 LPDs	3 extraneous substances	2 non-epi-layer originated extraneous substances and 1 mound

As is obvious from the results shown in Table 4, in the classification by a visual check, the detecting rate of LDPs as a precondition reached only 30 % (6 LPDs / 18 LPDs), which made clear that there was a problem before classification. And among the detected LPDs, only 50 % or so could be divided correctly. Thus, it was confirmed that, in the visual distinction by an inspector, the distinction was unstable, that it was difficult

to deal with higher-level requirements in a future wafer inspection, and that the probability that the defects etc. may escape his attention might become larger as wafers have larger diameters.

Example 2

Used laser surface inspection apparatus: SP-1 (produced by TENCOR)

Two light optics to one incidence

Used sample: 200 mm mirror-polished CZ silicon wafer

Wafer crystal plane (100)

The LPDs of the sample mirror-polished CZ silicon wafer were detected using the above laser surface inspection apparatus.

The data of the coordinates and standard particle conversion sizes of the LPDs obtained in each of the two light optics were organized, and the actual forms of the LPDs were presumed based on the classification shown in Table 2. Part of the results of the data processing are shown in Table 5.

Table 5

Detection results by laser surface inspection apparatus			AFM	Results
Low-angle light-receiving channel (nm)	High-angle light-receiving channel (nm)	Presumption		
Below detection limit	112	Scratch or s-pit	Scratch of length 3 μm (Fig. 10)	○
Below detection limit	115	Scratch or s-pit	Scratch	○
98	142	Scratch or s-pit	s-pit (Fig. 11)	○
110	149	Scratch or s-pit	s-pit	○
86	132	Scratch or s-pit	Scratch	○
91	Below detection limit	Grown-in defect in bulk	No unevenness observed	○
88	Below detection limit	Grown-in defect in bulk	No unevenness observed	○
132	133	Adherent particle	Adherent particle	○
104	109	Adherent particle	Adherent particle	○

Then, on the basis of the coordinate data of the obtained LPDs, the actual forms of the LPDs detected using the laser surface inspection apparatus were actually

confirmed using an AFM, and whether the classification based on Table 2 was correct or wrong was judged. The results are also shown together in Table 5.

In Figs. 10 and 11, typical examples of microphotographs of the actual forms of the LPDs confirmed using the AFM are shown. In Table 5, in order to clarify to which the LPDs shown in Figs. 10 and 11 correspond, the Figure numbers are included in the AFM column. In the method according to the Example, the LPDs could be accurately classified according to their forms with a probability of at least 90 % or more by a simple method using a laser surface inspection apparatus.

Industrial Applicability

This can be utilized for dividing to detect according to the types defects present on and near a semiconductor wafer surface, adherent particles and the like, which affect the electrical properties such as dielectric breakdown strength of LSIs and the like manufactured using semiconductor wafers so as to evaluate the semiconductor wafer quality.